Exhibit A

Analysis of Propane Supply Alternatives for Michigan

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PSC

PUBLIC SECTOR
CONSULTANTS

Prepared by

Public Sector Consultants
www.publicsectorconsultants.com

Prepared for

Michigan Department of Environment, Great Lakes, and Energy
and
Michigan Public Service Commission
www.michigan.gov

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Key Terms

Definitions of report key terms are provided by the U.S. Energy Information Administration online glossary tool (U.S. EIA n.d.b). Having accessible knowledge of industry terminology will support understanding of the propane life cycle as it relates to production, supply, and transportation.

Barrels: A unit of volume equal to 42 U.S. gallons.

Bulk terminal: A facility used primarily for the storage and/or marketing of petroleum products, which has a total bulk storage capacity of 50,000 barrels or more and/or receives petroleum products by tanker, barge, or pipeline.

Crude oil: A mixture of hydrocarbons that exists in liquid phase in natural underground reservoirs and remains liquid at atmospheric pressure after passing through surface separating facilities.

Dry natural gas: Natural gas which remains after: 1) the liquefiable hydrocarbon portion has been removed from the gas stream (i.e., gas after lease, field, and/or plant separation); and 2) any volumes of nonhydrocarbon gases have been removed where they occur in sufficient quantity to render the gas unmarketable. Note: Dry natural gas is also known as consumer-grade natural gas.

Fractionation: The process by which saturated hydrocarbons are removed from natural gas and separated into distinct products, or 'fractions,' such as propane, butane, and ethane.

Hydrocarbon gas liquids (HGL): A group of hydrocarbons including ethane, propane, normal butane, isobutane, and natural gasoline, and their associated olefins, including ethylene, propylene, butylene, and isobutylene. As marketed products, HGL represents all-natural gas liquids . . . and olefins. EIA reports production of HGL from refineries (liquefied refinery gas, or LRG) and natural gas plants (natural gas plant liquids, or NGPL). Excludes liquefied natural gas (LNG).

Liquified petroleum gases (LPG): A group of hydrocarbon gases, primarily propane, normal butane, and isobutane, derived from crude oil refining or natural gas processing. These gases may be marketed individually or mixed. They can be liquefied through pressurization (without requiring cryogenic refrigeration) for convenience of transportation or storage. Excludes ethane and olefins.

Natural gas liquids (NGL): A group of hydrocarbons including ethane, propane, normal butane, isobutane, and natural gasoline. Generally include natural gas plant liquids and all liquefied refinery gases except olefins.

Natural gas plant liquids (NGPL): Those hydrocarbons in natural gas that are separated as liquids at natural gas processing, fractionating, and cycling plants. Products obtained include ethane, liquefied petroleum gases (propane, normal butane, and isobutane), and natural gasoline. Component products may be fractionated or mixed. Lease condensate and plant condensate are excluded.

Natural gas processing plant: Facilities designed to recover natural gas liquids from a stream of natural gas that may or may not have passed through lease separators and/or field separation facilities. These facilities control the quality of the natural gas to be marketed. Cycling plants are classified as gas processing plants.

Refinery: An installation that manufactures finished petroleum products from crude oil, unfinished oils, natural gas liquids, other hydrocarbons, and oxygenates.

Wet natural gas: A mixture of hydrocarbon compounds and small quantities of various nonhydrocarbons existing in the gaseous phase or in solution with crude oil in porous rock formations at reservoir conditions. The principal hydrocarbons normally contained in the mixture are methane, ethane, propane, butane, and pentane. Typical nonhydrocarbon gases that may be present in reservoir natural gas are water vapor, carbon dioxide, hydrogen sulfide, nitrogen, and trace amounts of helium. Under reservoir conditions, natural gas and its associated liquefiable portions occur either in a single gaseous phase in the reservoir or in solution with crude oil and are not distinguishable at the time as separate substances.

Executive Summary

Propane is an important part of Michigan's energy supply portfolio, with more than 8 percent of the state's population using the fuel to support vital functions like home heating, cooking, and transportation. Propane serves consumers' economic needs as well, providing energy to many rural businesses, farms, and industrial customers. Considering the fuel's influence on the lives of Michigan residents, the State has invested significant time and resources into ensuring that propane customers have adequate, reliable, and affordable propane supplies.

With the creation of the Upper Peninsula (U.P.) Energy Task Force in June 2019, Gov. Gretchen Whitmer made Michigan's long-term energy security a priority. One of the primary objectives for the task force is to develop a plan for the state's propane supply in the event of a major disruption, such as the shutdown of the Line 5 pipeline that crosses the Straits of Mackinac. On August 5, 2019, the State issued a request for proposals seeking an assessment of alternative means for meeting Michigan's propane supply needs and recommendations for the best way to ensure Michigan residents and businesses have access to the energy they need into the future. The Michigan Department of Environment, Great Lakes, and Energy (EGLE) and the Michigan Public Service Commission (MPSC) engaged Public Sector Consultants (PSC) to support the work of the U.P. Energy Task Force and provide the State with the necessary information to understand alternatives for supplying Michigan's propane needs.

Issues related to Enbridge's Line 5 pipeline have garnered significant attention over the past five years, including a number of studies assessing the pipeline's safety, alternatives to the existing pipeline span crossing the Straits of Mackinac, the environmental impacts of a pipeline failure, and the impacts the disruption or closure of the pipeline would have on Michigan residents. This report does not seek to address the same questions posed in these earlier research efforts or to take issue with prior assessments, instead the State of Michigan has provided PSC with a clear directive: "Identify alternative approaches to meeting the propane needs of Michigan's residents and businesses" (State of Michigan 2019).

Given the amount of information already compiled on this subject, **PSC's study sought to leverage existing research and to expand on the collective understanding of how Michigan can prepare itself in the event of future propane supply disruptions.** This study does not attempt to address the questions related to the operation or safety of Enbridge's Line 5, nor does it consider the potential impacts of various spill scenarios. Instead the study focuses on the options available to supply the state with required propane volumes under three potential supply disruption scenarios.

In consultation with the U.P. Energy Task Force, PSC identified the following scenarios to serve as the basis for the evaluation of propane supply alternatives.[1]

- The first scenario considers the possibility of **a supply disruption of Enbridge's Lakehead System that delivers natural gas liquids (NGL) from Edmonton, Alberta, to Superior, Wisconsin, via Line 1.** This scenario assumes that Line 5 would not continue operating and would ultimately result in the loss of NGL and crude oil deliveries to propane production facilities and refineries in Superior, Wisconsin; Rapid River, Michigan; Detroit, Michigan; Sarnia, Ontario; Toledo, Ohio; and other downstream facilities. In addition, this scenario would restrict petroleum shipment from Michigan's northern Lower Peninsula to markets via Line 5. The potential impact of this scenario would jeopardize 51.4 percent of Michigan's current propane supplies.

- Scenario two also considers **a potential disruption of an Enbridge pipeline, Line 5 in this case**. Line 5 runs from Superior, Wisconsin, across Michigan's Upper Peninsula, under the Straits of Mackinac, and into Sarnia, Ontario. A disruption of Line 5 would eliminate the flow of NGLs to the Rapid River processing facility, interrupt shipments of Michigan petroleum production, and cut off crude oil and NGL deliveries to refineries and processing facilities in Detroit, Sarnia, Toledo, and other downstream facilities. Under this scenario, 46 percent of Michigan's propane supplies could potentially be impacted.

- The third scenario examines the impact of a weather-related supply disruption on propane supply and consumption. This scenario is modeled after the polar vortex event that took place during the 2013–2014 winter season. During this event, regional temperatures plunged to nearly 20 percent below ten-year averages. Additional supply-related challenges exacerbated the challenge posed by increased demand and resulted in dramatically higher propane demand across the country, but especially in the Midwest. Propane prices spiked during this period, leaving providers and customers to grapple not only with associated price hikes, but also supply shortages. In an extreme weather scenario, Michigan's demand would increase during winter months and current supply options could be inadequate to meet increased customer demand. In addition, regional supply constraints could result in higher delivery costs to meet customer needs.

PSC identified several sensitivities to consider while analyzing these scenarios that would potentially impact short- and long-term effects on propane supplies. The first sensitivity examines the potential for energy efficiency to reduce propane consumption in the long run and reduce the state's overall propane demands. Modeled on existing efficiency programs for natural gas customers, this sensitivity assumes annual investment in energy efficiency and savings potential for propane customers. The second sensitivity is based on the role seasonal temperatures play in driving propane consumption. This sensitivity integrates variability in temperature that could potentially impact statewide propane consumption to account for growing unpredictability of weather and abnormal

[1] PSC's assessment of these alternatives does not consider the nonpropane impacts these scenarios could have, such as the potential impact lost crude oil supply would have on other petroleum products, alternative fuel sources for meeting energy needs, or other environmental costs.

weather patterns. A third sensitivity included in this analysis considers how optimizing propane storage volumes through the use of customers' existing propane storage tanks could help mitigate supply disruptions and insulate customers and retailers from price volatility.

Summary of Results

PSC identified a number of robust and diverse alternative supply options for delivery to the Michigan market. These include sourcing from multiple supply hubs, with primary reliance on supply from Edmonton, Alberta, and Conway, Kansas, transported by rail, pipeline, and truck. Rail routes **from Edmonton to delivery sites in Michigan are the most cost-effective option, especially when propane is procured with a long-term focus on meeting demand throughout the year and using storage as needed to optimize price.** In addition to sourcing propane directly from a major supply hub like Edmonton, PSC found several propane storage terminals in neighboring states where shipments via various pipelines can be accessed and subsequently delivered to Michigan. The best terminal options vary depending on the distance from specific delivery points.

The modeling approach developed for this study provides an opportunity to evaluate the cost impacts and potential trade-offs associated with different procurement and storage configurations, such as purchasing propane stores during nonheating months. Depending on hub prices, the cost of incremental storage capacity can be an effective strategy for supplying propane.

Through the modeling exercise, PSC estimated costs for hundreds of different supply alternatives for selected delivery locations in Michigan. PSC identified the top four priority supply options based on cost. Given the quantity of propane required to mitigate the impacts of potential supply disruptions and the geographic dispensation of propane demand across Michigan, a single supply alternative would likely not be able to supply the quantities required. Based on this finding, PSC used a portfolio approach to calculate the impact of the different scenarios and sensitivities, finding an approach that would leverage the lowest-cost options for each delivery point to meet the needs of Michigan customers and provide supply diversity to mitigate risk. Sensitivities around energy efficiency and utilization of customer storage analyzed in conjunction with the scenarios provide options for reducing the impact of supply disruptions as well. Sensitivities related to extreme weather show the compounding effects of supply disruptions and variability in demand for propane.

While PSC's analysis identified some alternative supply options with prices comparable to those offered at the Rapid River and Sarnia hubs, the overall impact from the scenarios modeled illustrates that wholesale propane prices will likely increase in the event of supply disruptions. While this study focuses on wholesale propane pricing, it is recognized that these increases on the wholesale level would be amplified at the retail level.

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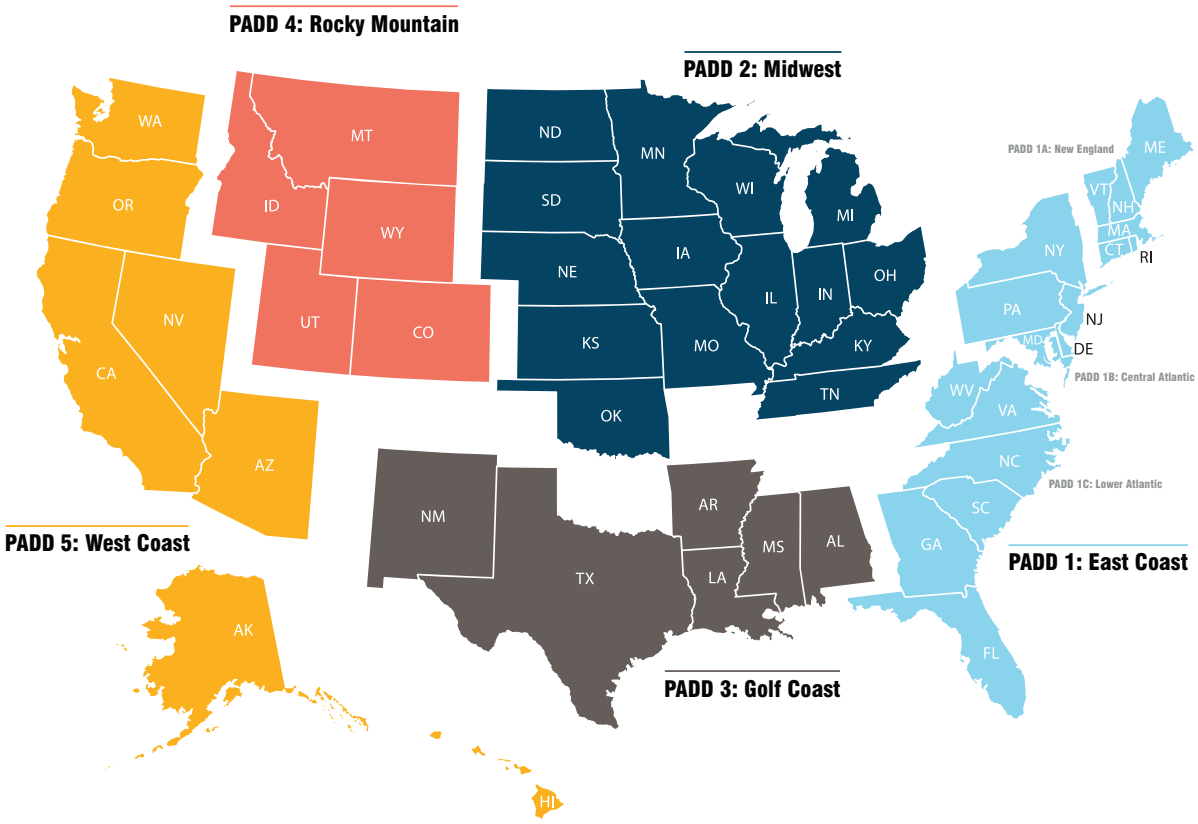
Regional Propane Production

Propane supply and disposition is not reported at the state level in publicly available datasets. Instead, this information is reported at the regional level for the five Petroleum Administration for Defense Districts (PADDs). Michigan is part of PADD 2, or the Midwest region, and includes Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, and Wisconsin (U.S. EIA n.d.d). A map of these districts is provided in Exhibit 4.

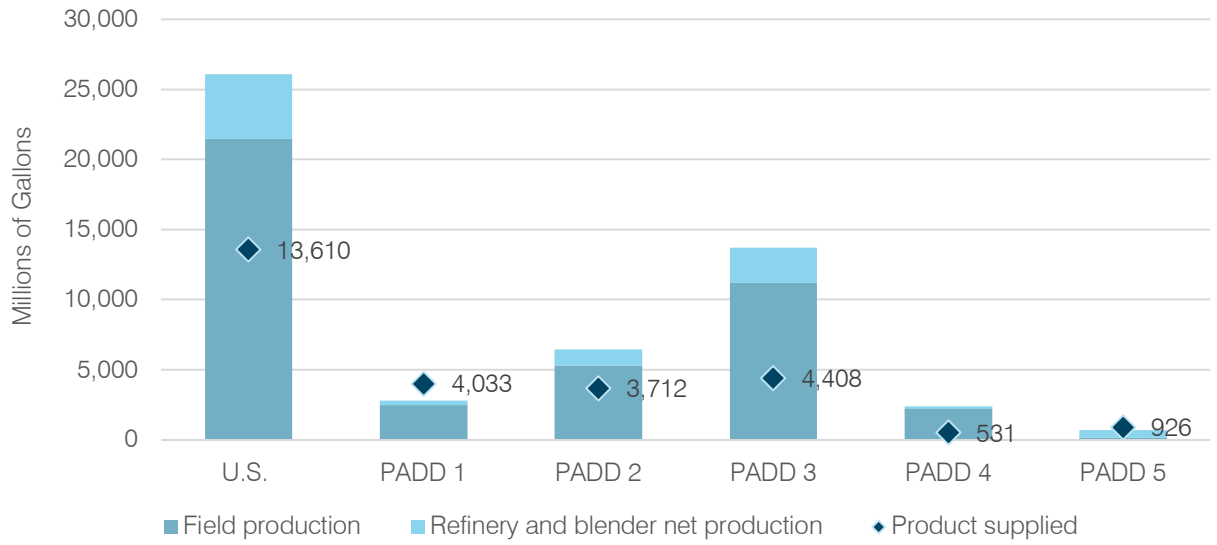
EXHIBIT 4. Petroleum Administration for Defense Districts



Source: U.S. EIA n.d.d

PADD 2 produces 6.455 billion gallons of propane, or 24.7 percent of U.S. production, the second-highest volume of the five PADDs. Only PADD 3 produces more propane, with 52.5 percent of total U.S. production—more than double PADD 2's production. Of the five PADDs, only PADDs 2, 3, and 4 produced more propane than they supplied to customers in 2018. As noted above, the majority of U.S. propane production comes from field production at natural gas plants. Only PADD 5 has more propane production from refineries and blenders than natural gas plant field production (U.S. EIA January 31, 2020c). Propane production by PADD is shown in Exhibit 5.

EXHIBIT 5. Propane Production, by PADD and by Source, 2018



Note: Percentages included in the chart indicate the portion of total U.S. production from each PADD.
Source: U.S. EIA January 31, 2020c

Michigan Propane Production

While PADD 2 has substantial propane production capacity, Michigan has just three facilities that produce propane—one natural gas processing plant, one fractionator, and one refinery. Together, these three facilities produce an estimated 77.3 million gallons of propane per year.

- The Lambda Energy Resources natural gas plant located in Kalkaska, Michigan, extracts propane from wet natural gas produced in the northern Lower Peninsula.[5] The plant is capable of producing over 44,100 gallons of propane per day, or 16.1 million gallons per year (MPSC September 2019).
- The state's only fractionation facility, located in Rapid River, Michigan, in the central Upper Peninsula, is owned and operated by Plains Midstream Canada. The Rapid River facility draws NGLs directly from Enbridge Line 5 and has a gross production capacity of 315,000 gallons per day (Plains Midstream Canada 2019). Estimated actual daily production from Rapid River is approximately 84,000 gallons and annual production is 30.6 million gallons (MPSC August 2019).
- Michigan's only refinery, Marathon Petroleum Corporation's Detroit facility, is the third source of propane production in the state. Crude oil is supplied to Marathon's refinery via a number of sources, including Enbridge Lines 78 and 5. The refinery produces an estimated 84,000 gallons of propane per day, which equates to 30.6 million gallons per year (MPSC September 2019).

[5] EIA defines wet natural gas as "a mixture of hydrocarbon compounds and small quantities of various nonhydrocarbons existing in the gaseous phase or in solution with crude oil in porous rock formations at reservoir conditions. The principal hydrocarbons normally contained in the mixture are methane, ethane, propane, butane, and pentane" (U.S. EIA n.d.b).

Ontario Propane Production

In addition to domestic propane production, Michigan also draws on propane produced in Ontario, Canada. Like the Rapid River facility, the propane production facilities in Sarnia, Ontario, are owned by Plains Midstream Canada and receive NGLs directly from Enbridge's Line 5. The facility has the operating capacity to produce 4.4 million gallons of propane per day (Plains Midstream Canada 2019). The estimated total production from Sarnia is nearly 1 billion gallons per year (MPSC August 2019).

Other Regional Propane Production

Propane Processing Capacity

Another propane processing facility served by Enbridge's Lakehead system, is located in Superior, Wisconsin. Superior is approximately 100 miles from the far western border of the Upper Peninsula. Operated by Plains Midstream Canada, the Superior facility has the capacity to produce 420,000 gallons of propane per day (Plains Midstream Canada 2019).

One of the larger propane processing facilities in the region, the Aux Sable plant in Channahon, Illinois, (approximately 50 miles southwest of Chicago) is situated at the terminus of the Alliance Pipeline. The Alliance Pipeline does not deliver NGLs, instead shipping wet natural gas from British Columbia, Alberta, and North Dakota directly to the Aux Sable facility. The plant has the capacity to produce over 5.5 million gallons per day of NGL consumer-grade products, including ethane and propane. PSC was not able to identify specific production volumes of propane from this facility. Assuming 30 percent of NGL products extracted are in the form of propane, the output from Aux Sable is 1.65 million gallons per day (Pembina Pipeline Corporation 2019). During interviews with companies contacted for the study, some noted that they do procure propane supplies from this facility to various locations in Michigan.

Refinery Capacity

There are other sources of propane production in close proximity to Michigan, including a number of oil refineries that produce propane as a biproduct of the refining process. Refineries process crude oil and other unprocessed petroleum products into refined petroleum products like gasolines, diesel fuel, asphalt, and others (U.S. EIA n.d.b). There are 13 refineries operating in Michigan and neighboring states. Based on assumptions for propane production as a percentage of refineries' total capacity, PSC estimates that these 13 facilities produce 665 million gallons of propane annually. There are an additional 14 operating refineries in PADD 2. Using the assumed rate of propane production, the 27 total refineries in PADD 2 produce 1.053 billion gallons of propane per year, aligning with the U.S. Energy Information Administration's (EIA's) data for propane production from PADD 2 refineries in 2018, which totaled 1.124 billion gallons.

EXHIBIT 6. Operating Capacity of PADD 2 Refineries and Annual Propane Production Estimates, 2019 (Million Gallons)

State	City	Company	Total Operable Capacity	Estimated Propane Production
Illinois	Joliet	ExxonMobil	3,658	61
	Robinson	Marathon Petroleum Corporation	3,756	62
	Lemont	PDV Midwest Refining	2,748	46
	Wood River	WRB Refining	5,120	85
Indiana	Whiting	BP Products	6,592	109
	Mount Vernon	CountryMark Cooperative	442	7
Michigan	Detroit	Marathon Petroleum Corporation	2,146	36
Minnesota	Saint Paul	Flint Hills Resources	4,906	81
	Saint Paul	St. Paul Park Refining	1,510	25
Ohio	Toledo	BP-Husky Refining	2,376	39
	Lima	Lima Refining Company	2,713	45
	Canton	Marathon Petroleum Corporation	1,426	24
	Toledo	Toledo Refining Company	2,649	44
Total			**40,042**	**665**

Note: Production from Marathon's Detroit refinery is also discussed in the section of this report titled Michigan Propane Production. Propane production estimates are based on a 1.66 percent average propane yield rate from crude oil production (MPSC September 2019). Actual propane production will vary by refinery and time of year.
Source: U.S. EIA January 1, 2019

Supply and Disposition

Though propane production has risen in the U.S. over the past decade, the national landscape for propane supply and disposition has also changed as new supply configurations and greater emphasis on exports have altered what happens to propane after production. In addition to tracking propane production, the U.S. EIA tracks imports and exports, movement of product between regions, and propane stocks. Supply and disposition vary regionally; the characteristics of each PADD's propane supplies are as follows.

- PADD 1: East Coast does not produce enough propane to meet its needs on an annual basis and relies on shipments from other regions and, to a lesser extent, imports. Despite relying on imports and shipments from other regions, PADD 1 is the second-largest exporter of propane.
- PADD 2: Midwest has more than enough production to meet its annual supply needs and ships a significant amount of propane to other PADDs. PADD 2 receives the most propane imports, most coming from Canada and has limited propane exports.

- PADD 3: Gulf Coast is by far the largest propane producing region and has the most product supplied. PADD 3 also receives the most propane shipments from other regions and is responsible for over 90 percent of all exports.
- PADD 4: Rocky Mountain produces more propane than it ultimately supplies. The region does not receive a large amount of imports and had zero exports in 2018. The largest share of PADD 4 propane is supplied to other regions.
- PADD 5: West Coast does not produce enough propane to supply the volumes required and relies on imports and shipments from other regions to meet nearly one quarter of its needs, though exports from PADD 5 were almost equal to imports in 2018.

Exhibit 7 provides further insight into how the propane market functions and the overall flow of product.

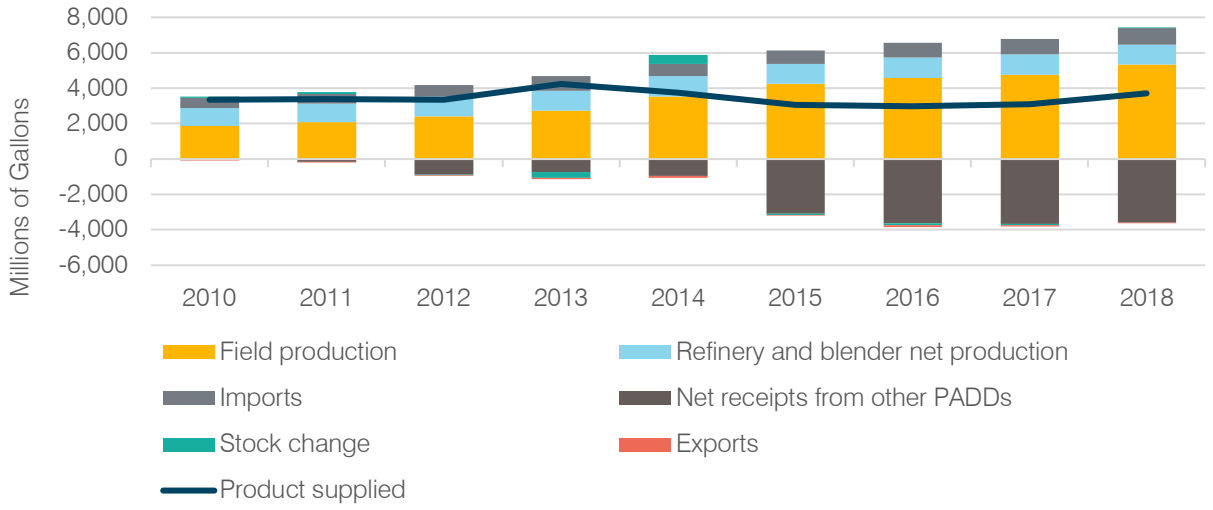
EXHIBIT 7. Propane Supply and Disposition, 2018 (Millions of Gallons)

	Field Production	Refinery and Blender Net Production	Imports	Net Receipts from Other PADDs	Stock Change	Exports	Product Supplied	Ending Stocks
PADD 1	2,497	324	569	1,537	6	889	4,033	251
PADD 2	5,331	1,124	928	-3,569	35	68	3,712	869
PADD 3	11,217	2,483	0	3,903	31	13,164	4,408	1,439
PADD 4	2,276	127	166	-2,042	-4	0	531	59
PADD 5	155	561	470	170	-2	432	926	59
U.S.	21,476	4,620	2,133	0	65	14,553	13,610	2,677

Note: Columns do not add up to U.S. totals due to rounding.
Source: U.S. EIA November 29, 2019

Review of propane supply and disposition for PADD 2 over time reveals propane market changes. In 2010, PADD exports and shipments to other regions were just over 1 percent of total product supplied and the region's propane production and imports were in alignment with supply needs (U.S. EIA. November 29, 2019). However, since 2010, PADD 2 production has more than doubled and imports have increased by 63 percent. The increased volume of propane in PADD 2 is not serving increased need for supply, which has remained relatively consistent in the last nine years, instead the main change has been in the flow of propane from PADD 2 to other regions (see Exhibit 8).

EXHIBIT 8. PADD 2 Propane Supply and Disposition, 2010–2018

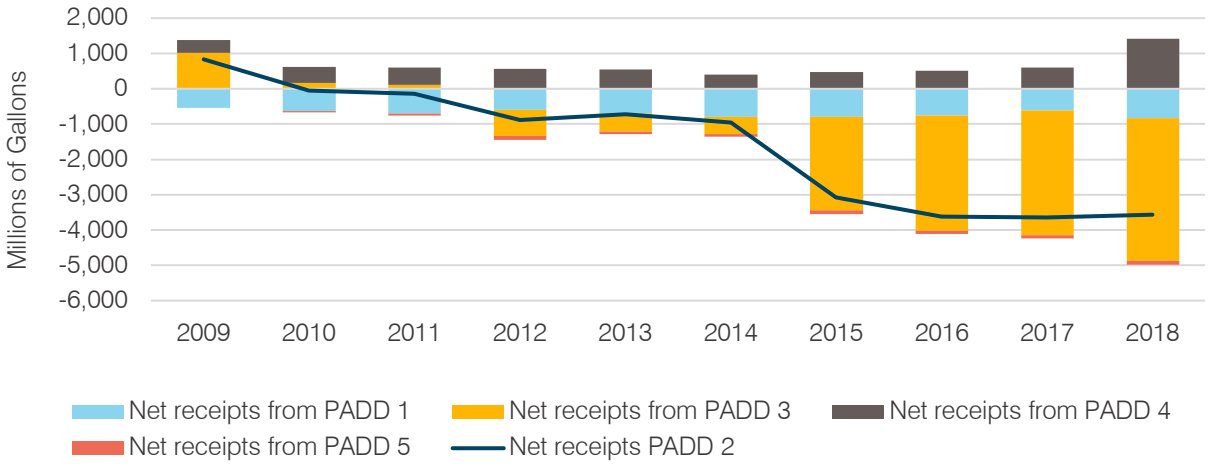


Source: U.S. EIA. November 29, 2019

Regional Supply and Disposition

PADD 2 is the largest exporter of propane to other regions of the country, supplying 3.57 billion gallons to other PADDs in 2018. PADD 2 propane shipments to other regions have increased dramatically since 2010. PADD 3 is by far the largest recipient of propane shipments from PADD 2, receiving 4.03 billion gallons in 2018. The majority of this increase is due to reconfiguration of pipelines to move propane from PADD 2 into PADD 3. Pipelines accounted for over 88 percent of propane shipments from PADD 2 to PADD 3 in 2018. PADD 2 is also a net exporter of propane to PADD 1 and PADD 5. Exhibit 9 breaks down net propane receipts in PADD 2 (U.S. EIA January 31, 2020d).

EXHIBIT 9. PADD 2 Net Receipts of Propane, by Pipeline, Tanker, Barge, and Rail from Other PADDs



Source: Source: U.S. EIA January 31, 2020d